FEEG6013 Group Design Project

GDP 28: Access Gate for Disabled Ramblers

Group Members:
Mark Newman
Aaron Horsfield
Jessica Shum
James Maybey
Ming Sheng

Supervisor:
Prof. Anna Barney

Co-Supervisor:
Prof. David Richards

2023/24

Group Members and Roles

Mark Newman:

Team Leader

Aaron Horsfield:

Vice Team Leader & Electronics Lead

Jessica Shum:

Ethics and Research Lead

James Maybey:

CAD and Design Lead

Ming Sheng:

Secretary and Treasurer

The Brief

Design a structure that **allows mobility scooters** through but **excludes motorcycles**

disabled ramblers

Aim and Objectives

Aim: Design and manufacture a prototype structure that is both motorcycle-deterring and more accessible for mobility scooter users than current designs on the market

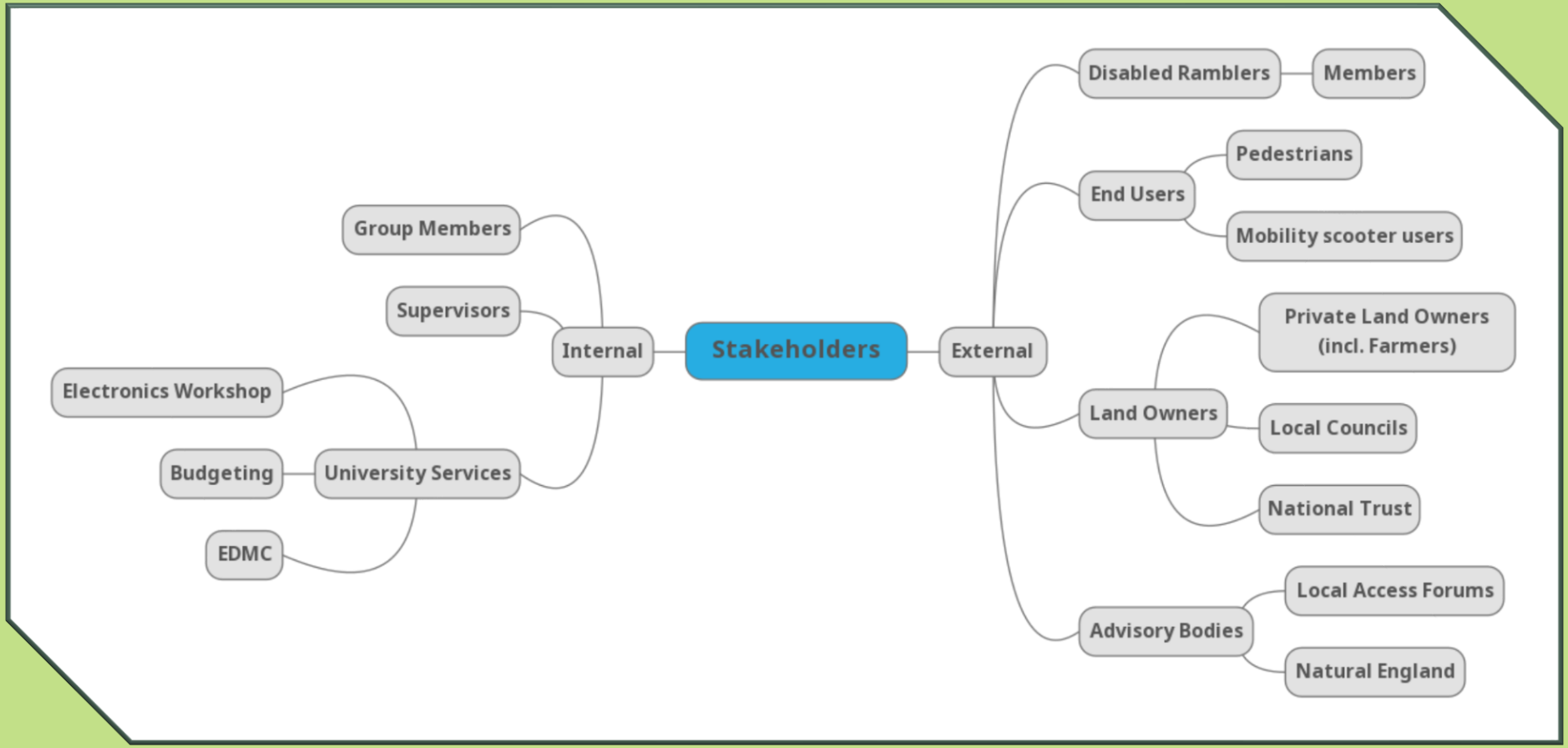
Objectives:

1. Investigate existing designs and viewpoints of relevant stakeholders
2. Form a product design specification and identify areas for improvement
3. Produce multiple design solutions that resolve the design brief
4. Construct and test a full-scale prototype of a selected design
5. Use feedback from testing to suggest improvements to the design

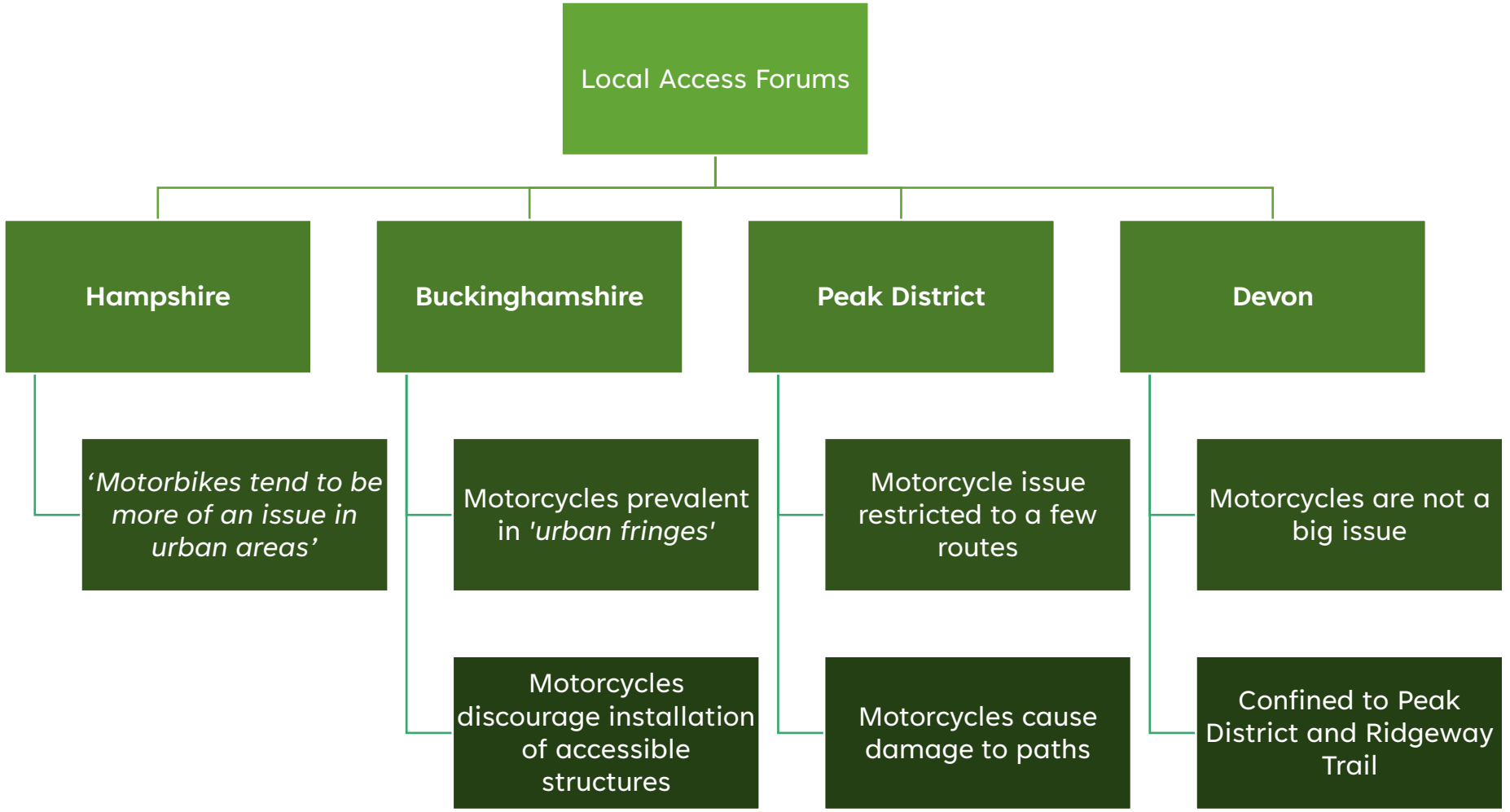
Contents

Background Research

Identification of Stakeholders



Scope of the Motorcycle Issue



Legal Aspects

Equality Act 2010:

- Requirement for adjustments to be made where a *'physical feature puts a disabled person at a substantial disadvantage'*

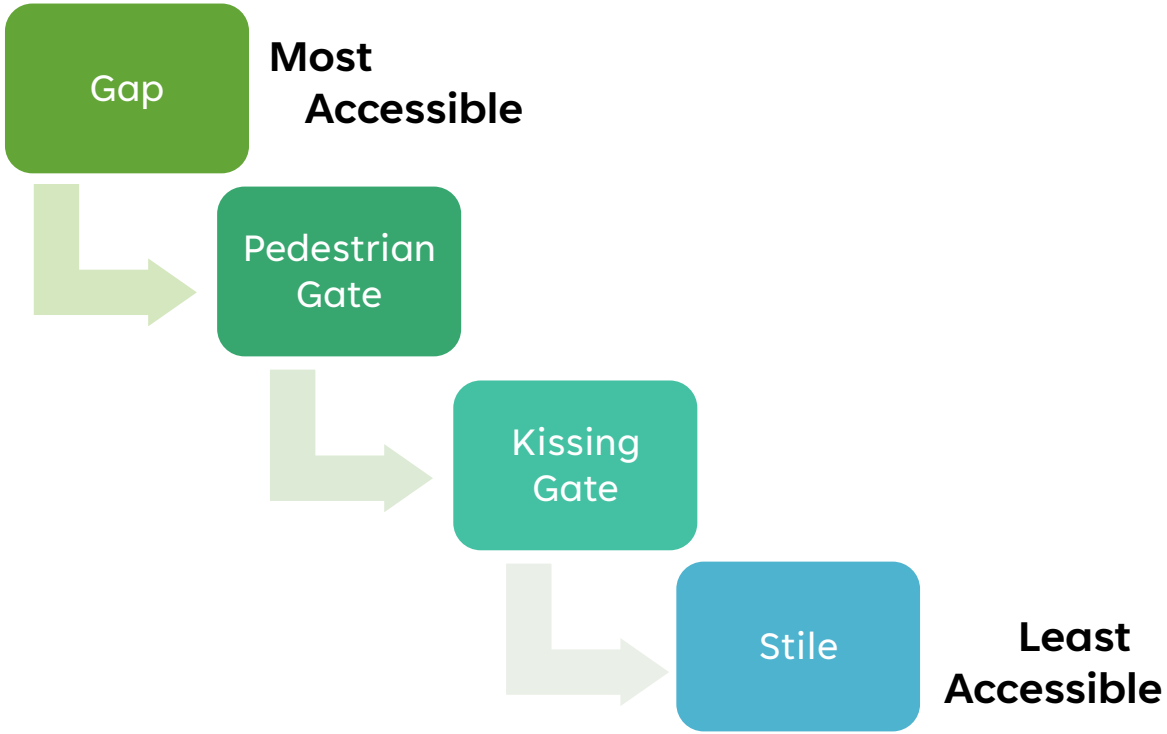
Highways Act 1980:

- Permission to erect a structure on a PRoW can only be granted for **stock proofing**

Current Advice

BS5709:2018

- Provides **guidance** on **best practice** for gaps, gates and stiles
- Advisory panels use BS5709:2018 to **inform** their **recommendations**
- **Compliance** means a structure is **more likely** to be **recommended**



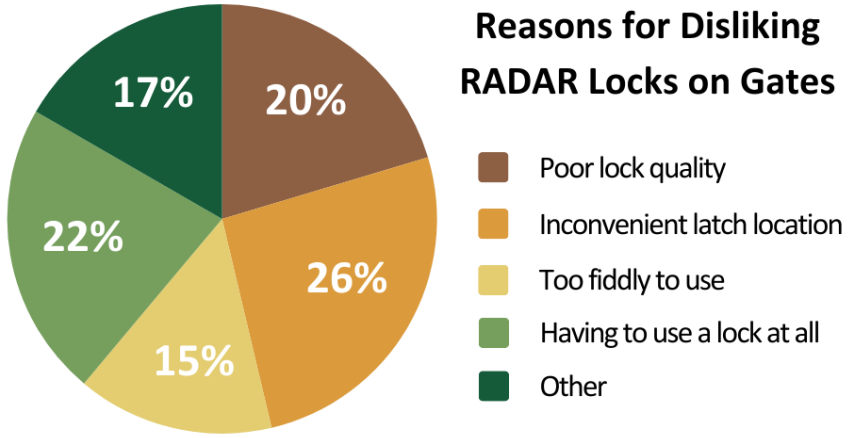
User Opinions on Existing Structures

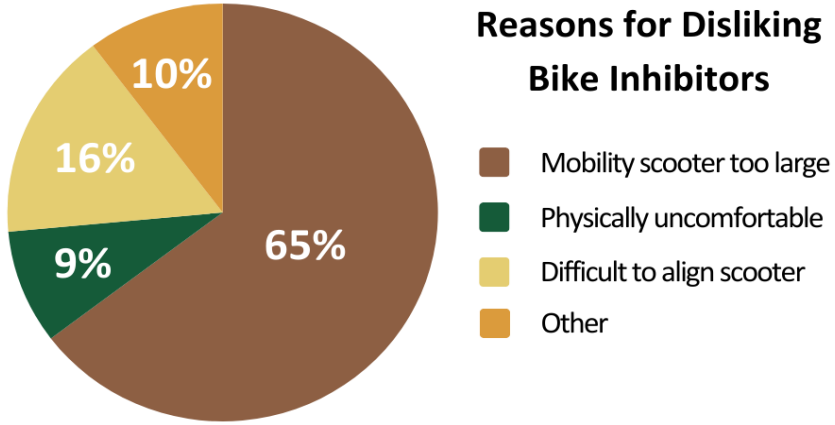
91% HAVE BEEN **DETERRED FROM A TRIP** BY THE THOUGHT OF **USING A GATE**

70% IDENTIFIED **PUSHING AWAY** AS THE **EASIEST MOTION** FROM A MOBILITY SCOOTER

80% RATED THEIR EXPERIENCE WITH **BIKE INHIBITORS** AS **NEGATIVE**

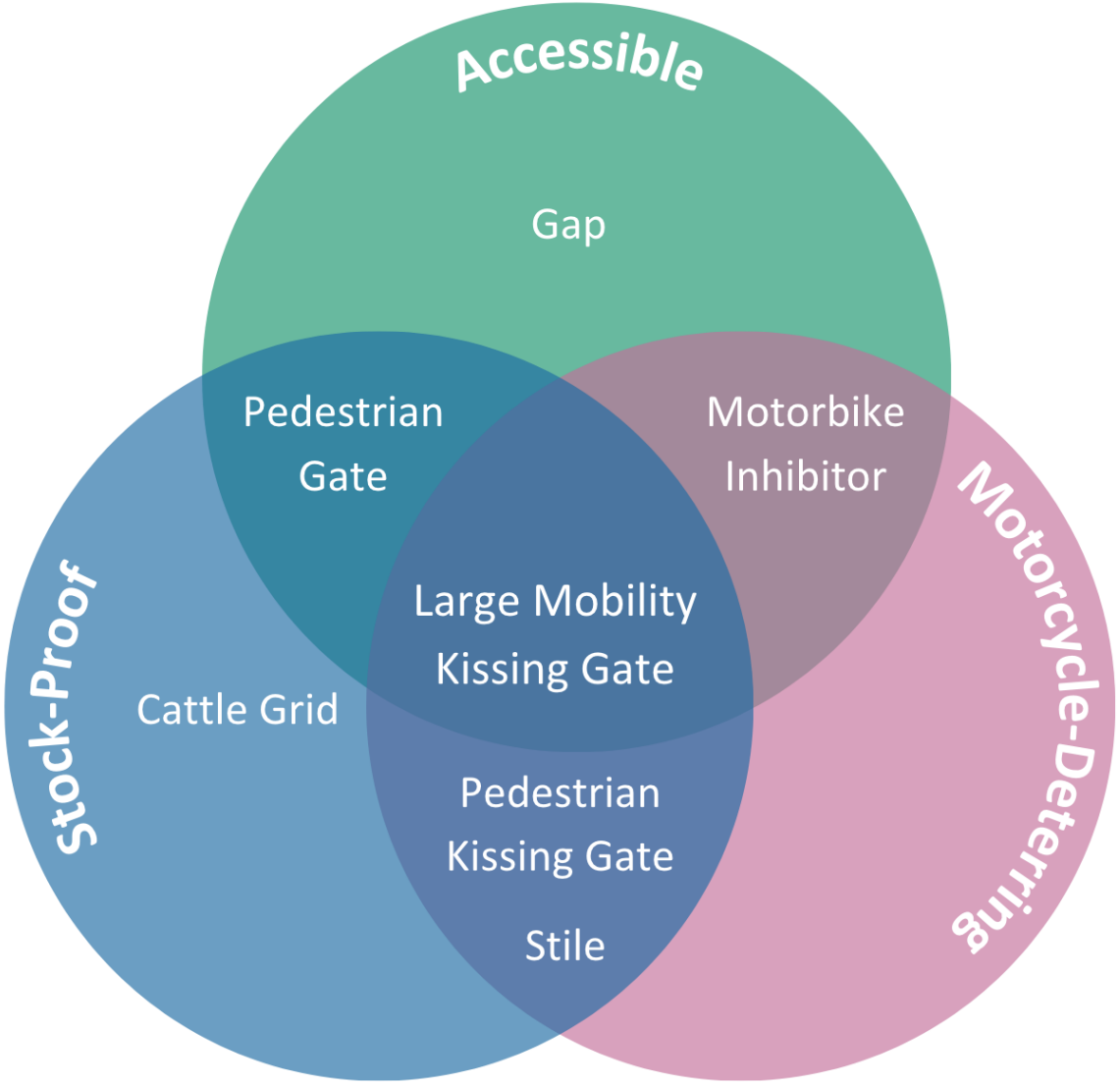
33% RATED THEIR EXPERIENCE WITH **RADAR LOCKS** ON GATES AS **NEGATIVE**





Existing Gates & Structures

- Reflects the **intention** of each solution
- **Effectiveness** is often **subjective**



Existing Gates & Structures: Motorcycle Deterrents

Stiles

+ Steps allow pedestrian access
- Mobility scooter access not possible

Large Mobility Kissing Gate

+ Hoop section prevents motorcycle access
+ RADAR key padlock allows mobility scooter access
- Position of padlock is awkward

Bike Inhibitor

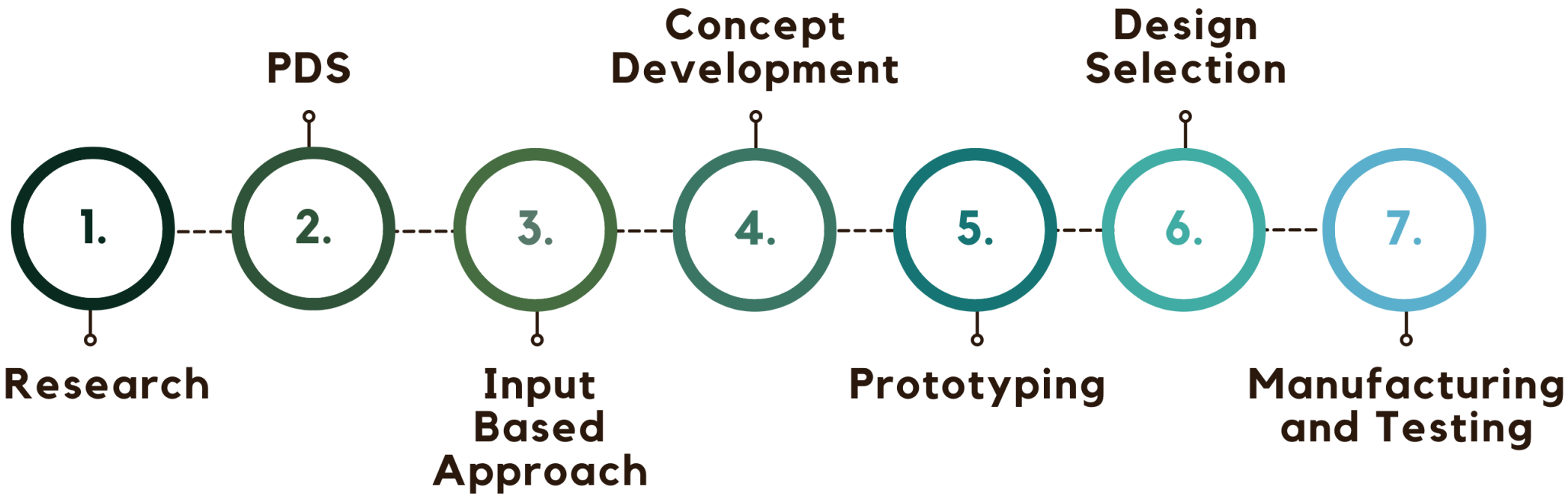
+ Fixed width -> catches handlebars of motorcycles
- Limited clearance

Summary of Findings

- **Keys** are **difficult** to use
- Bike inhibitors prevent large scooters
- **Hands-free** operation preferable
- In rural areas, **motorcycles** are a **perceived issue**
- **Motorcycle** issues are **localised** & confined to **'urban fringes'**
- **Larger landowners** (National Trust) may be willing to **pay more**
- **Maintenance** of current gates is **infrequent**

Design Process

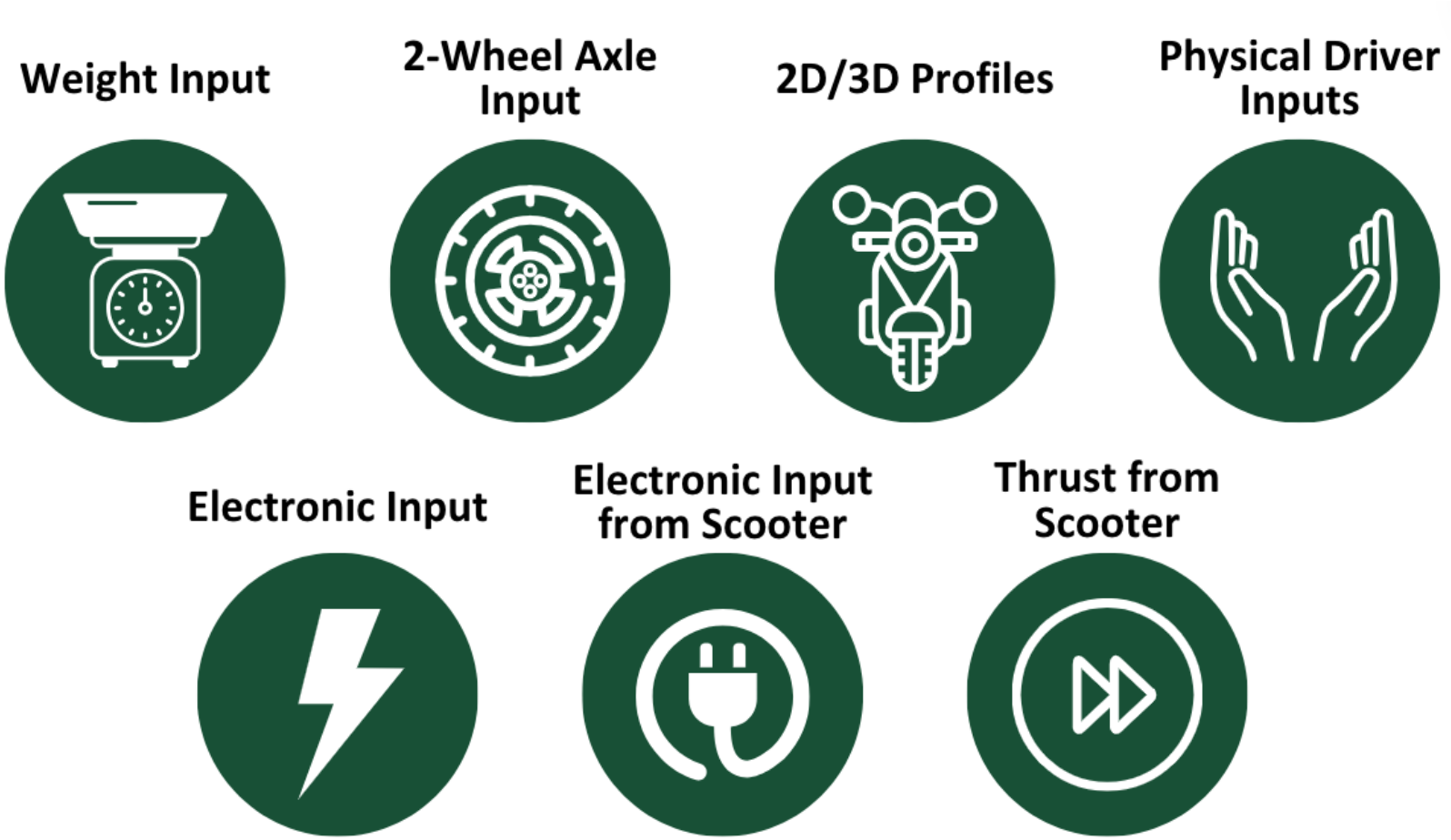
Design Process Overview



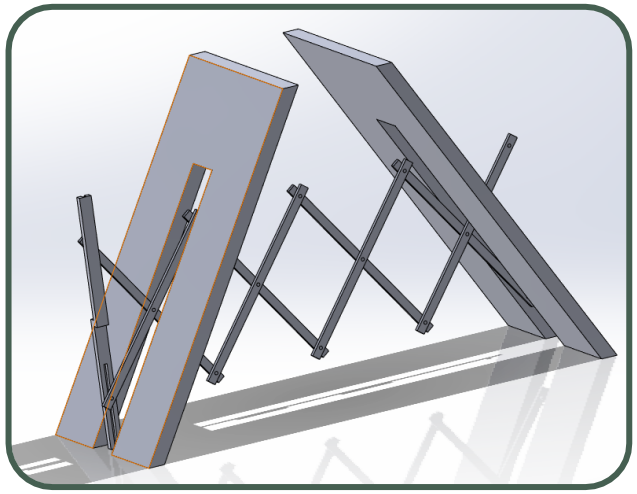
Product Design Specification

Design Specification Category	Specification Target
Aesthetic	• Compliments surroundings
Cost	• Manufacturing cost **< £700**
Customer	• **Accessible** from scooter seat • **Operation clear** to the user
Environment	• Fully **reusable** or **recyclable**
Safety	• Protruding **edges rounded** • Few pinch points
Size	• Minimum **clearance 1.1m**
Function	• Mobility scooter ✔ • Pedestrians ✔ • Motorcycles ✘
Materials and Manufacturing	• Standard material sizes • **Weatherproof**

Input-Based Approach

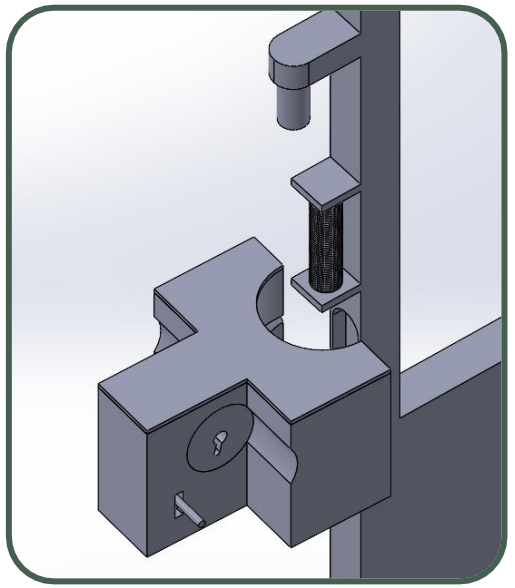


Design Concepts



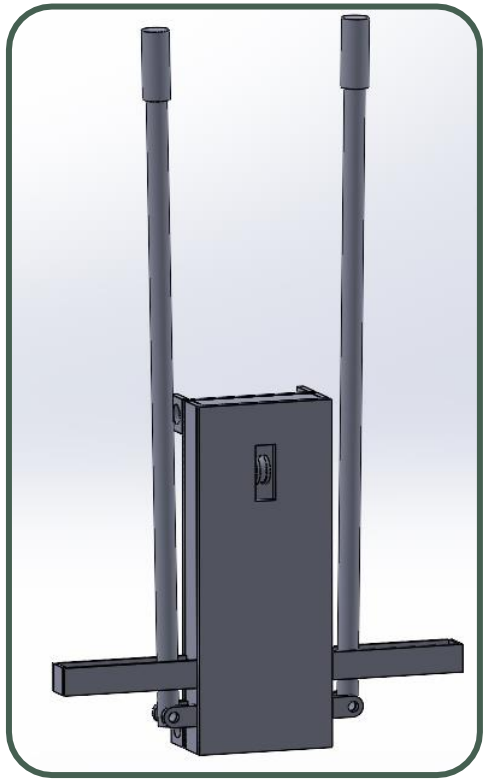
A-Frame

- Reassessment of existing frame dimensions
- Considered mobile and static versions



RADAR Kissing Gate

- Positional improvements
- One-handed operation



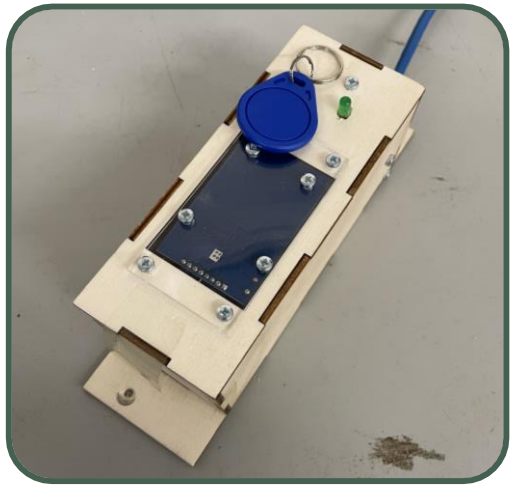
Lever Operated

- Easy to operate
- Can incorporate RFID + RADAR key

Design Concepts

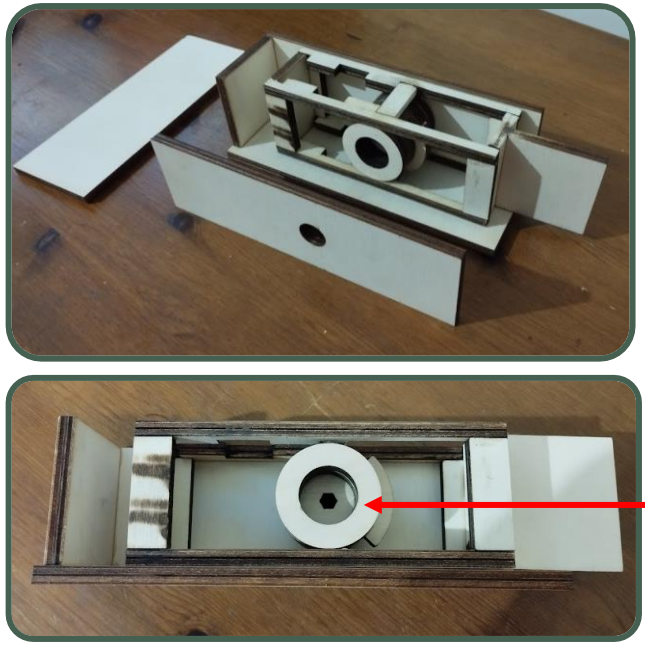
Ride-On Mechanism

- Exploits 2 parallel wheels on one axle
- Completely hands-free



RFID Kissing Gate

- Easy-tap fob
- Stock electronic components



Pole Key

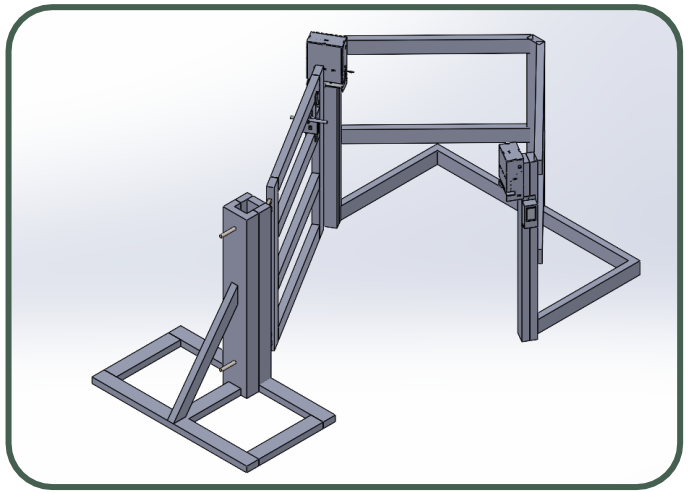
- Custom key profile fitted to a mobility aid
- Well-developed existing mechanism

Design Matrix

Category	Weighting (1-5)	Reasoning
Aesthetic	1	Easier to market
Cost Efficiency	2	Competitive pricing
Manufacturing and Material Efficiency	3	Reduce production costs and environmental impact
Maintenance	4	Ensure longevity and functionality of structure
Ease for Mobility Scooters	5	Design Project Aim
Prevention of Motorcycles	5	Design Project Aim
Ease to Make Two-Way	4	Easier for those in wheeled mobility aids
Self-Closing	5	Vulnerable to livestock/those with unauthorised access
Access for Pedestrians	3	Desirable to install on public footpaths
Spatial Requirements	2	Smaller ground footprint

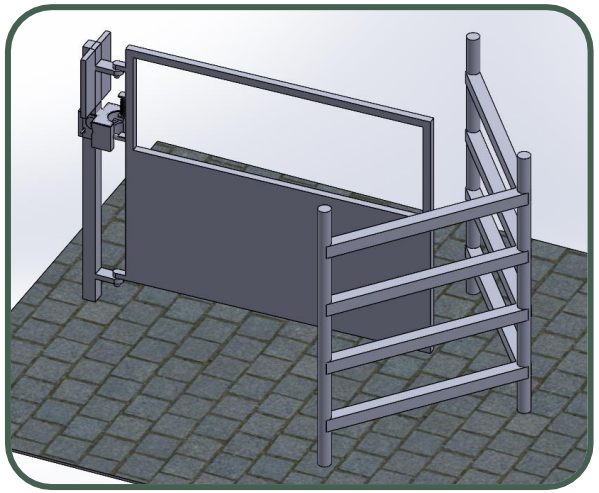
The benchmark Aston 2-way gate produced a score of 113

Design Selection



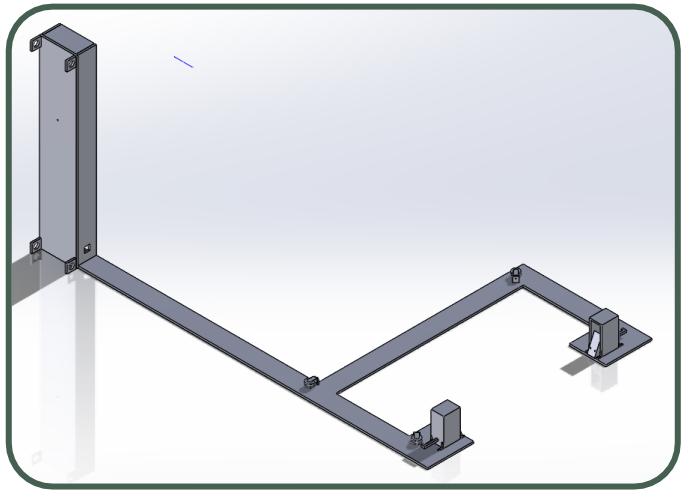
RFID Kissing Gate

- Matrix Score of **120**
- Electronic concept
- Uses RFID to unlock the mechanism
- Permits standard foot traffic



RADAR Kissing Gate

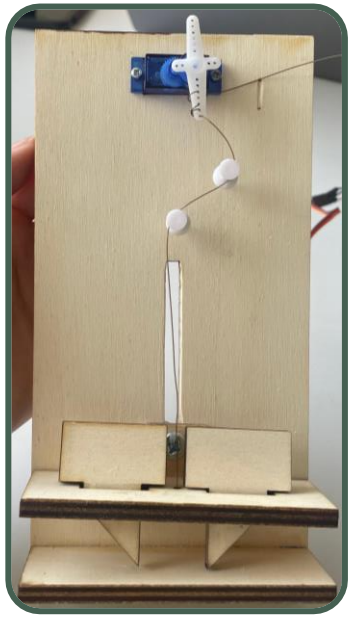
- Matrix Score of **119**
- Fully mechanical concept
- Must be reset by user
- Permits standard foot traffic



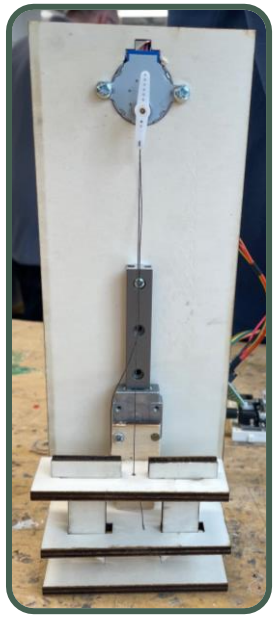
Ride-On Mechanism

- Matrix Score of **114**
- Fully mechanical concept
- Standard self-closing method
- Hands-free operation

Prototyping: RFID Pawls + Housing



- Floating pawls
- Pulley system



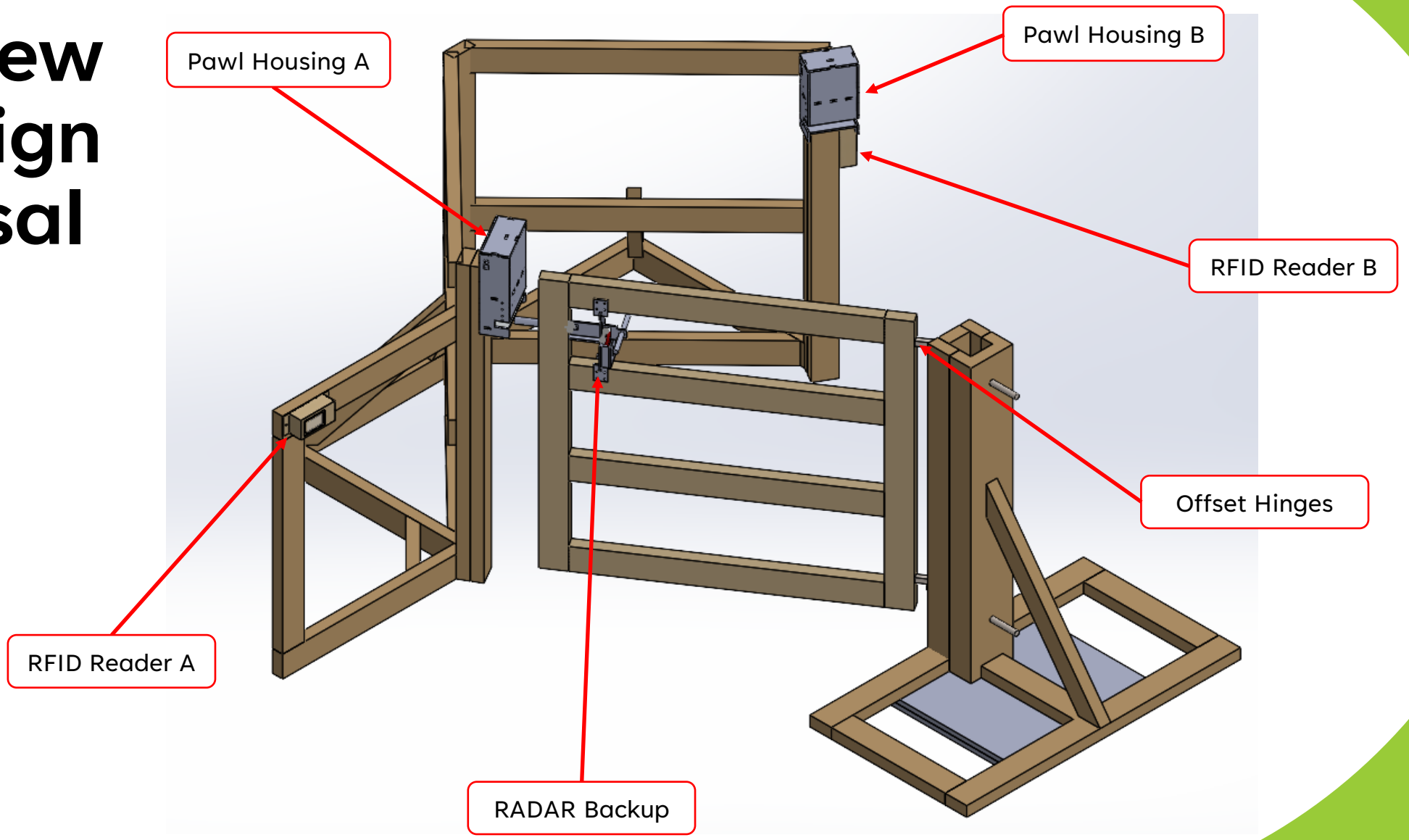
- Addition of linear rail

- Creation of the pawl housing
- Limit switches
- L-shaped crank

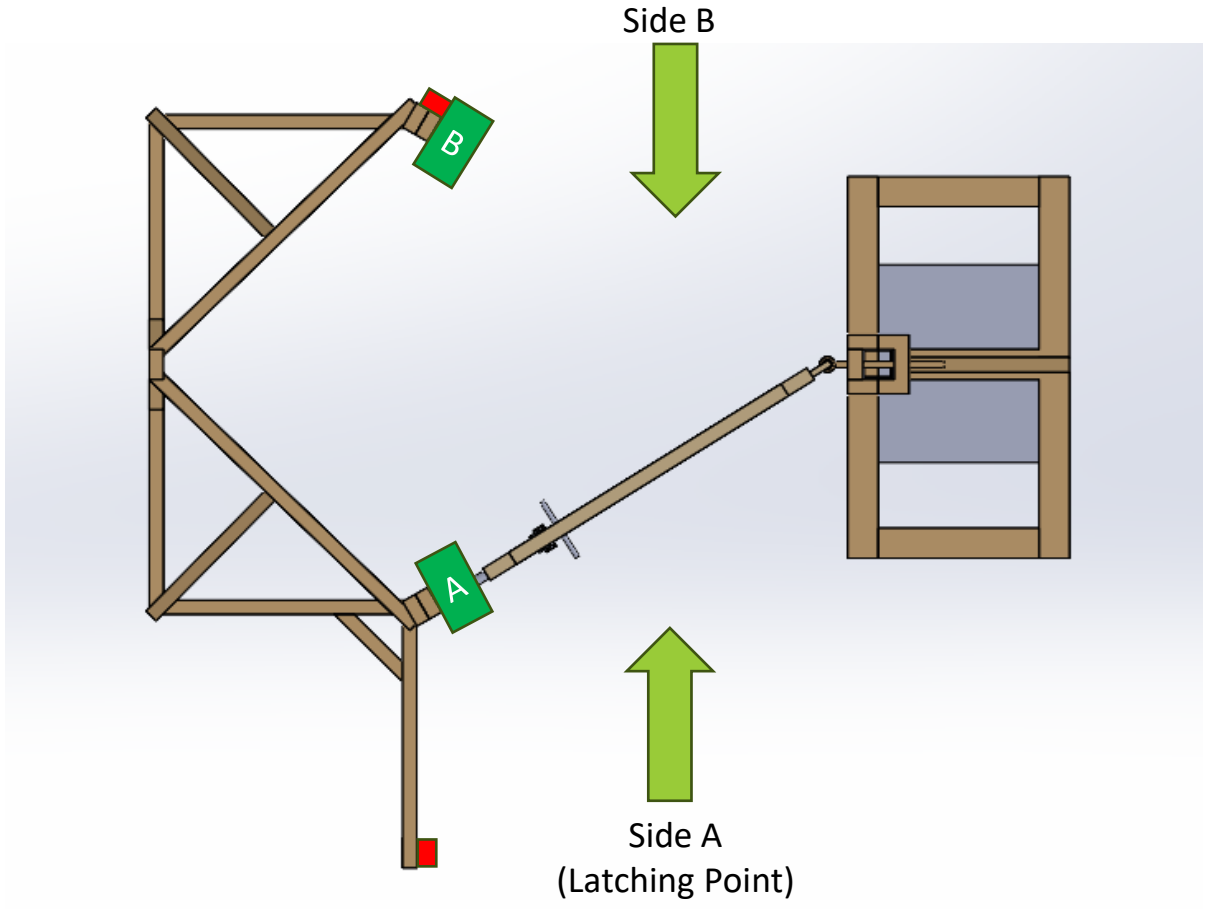
- Two linear rails
- Hinged pawls
- Connecting rod

Final Design Proposal

Overview of Design Proposal

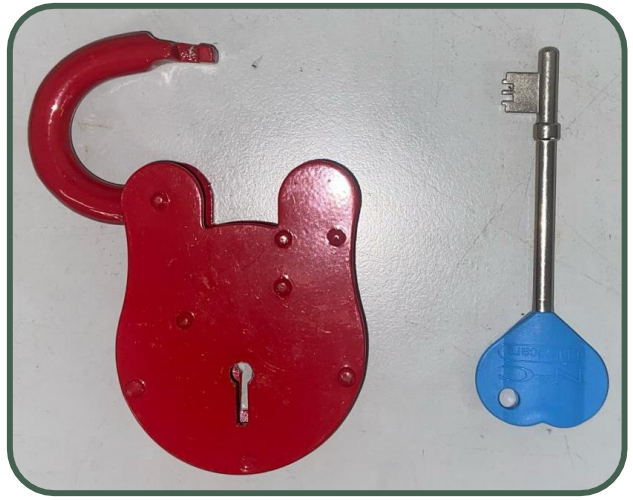


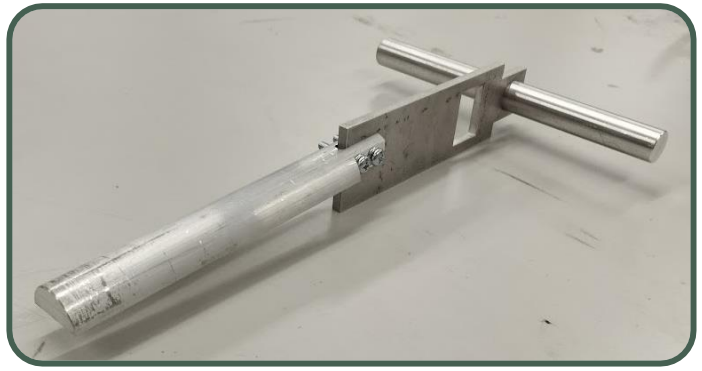
Plan View

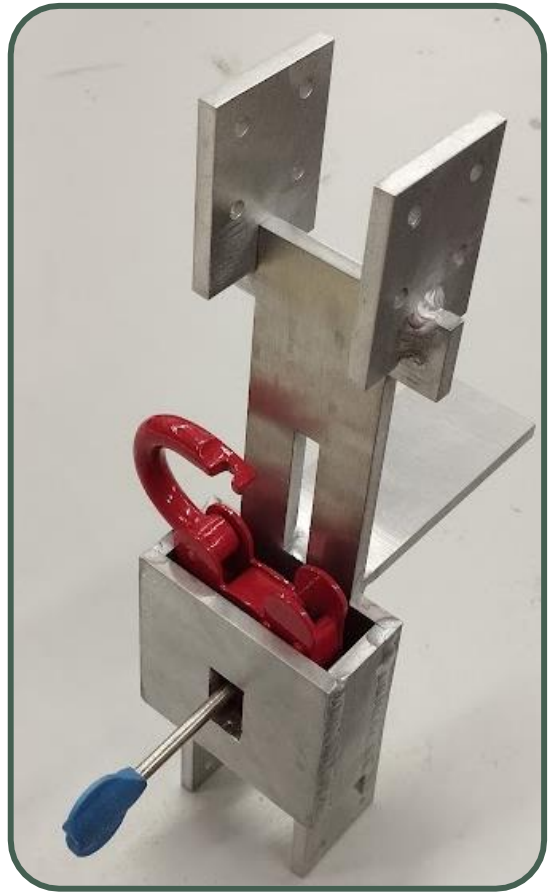


Latch Strike Mechanism

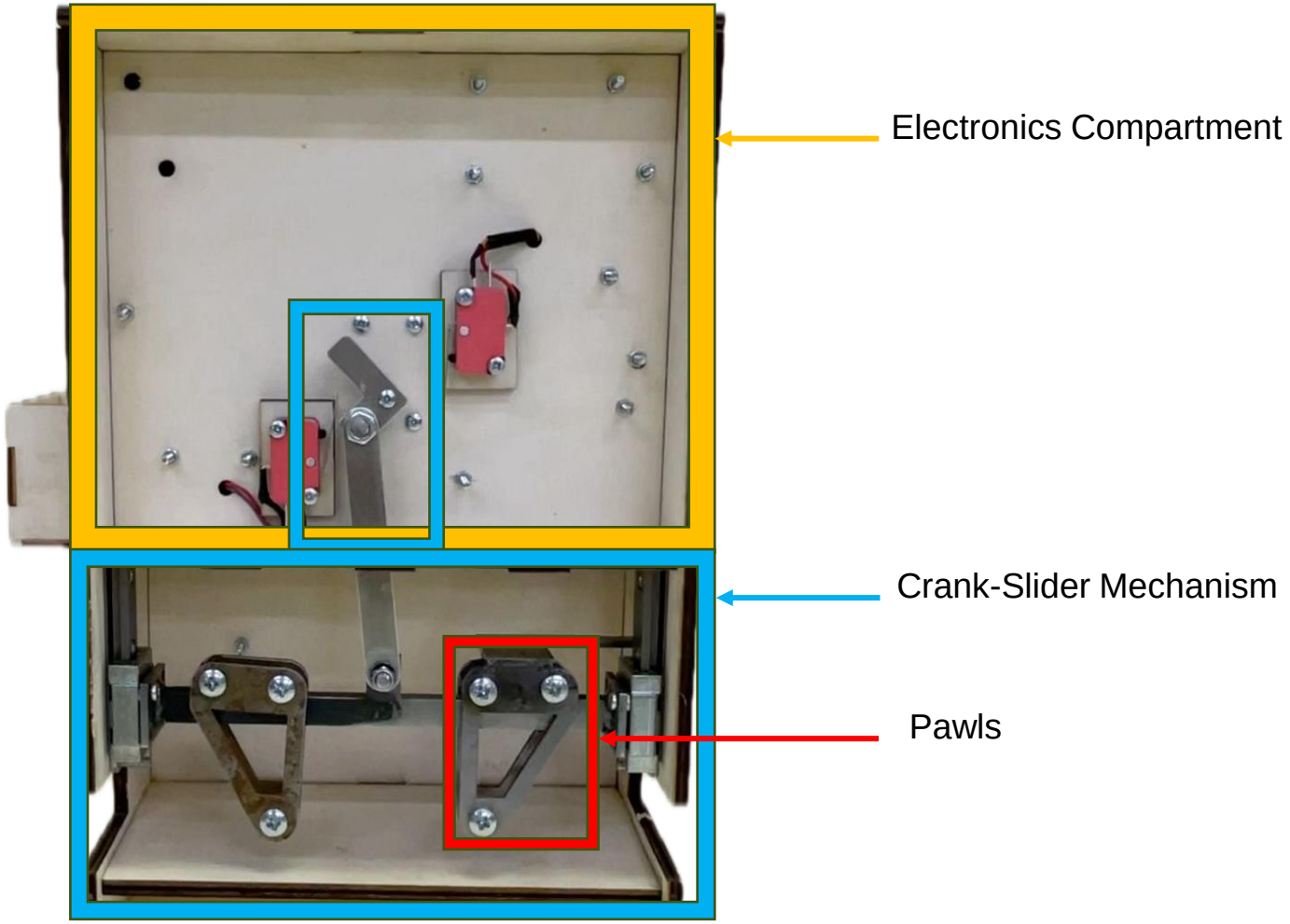
- Reproduced both a RADAR lock bracket and strike
- **Semi-circular strike** profile
- Bracket design to fit 45x95mm wood profiles
- Lightweight **aluminium**



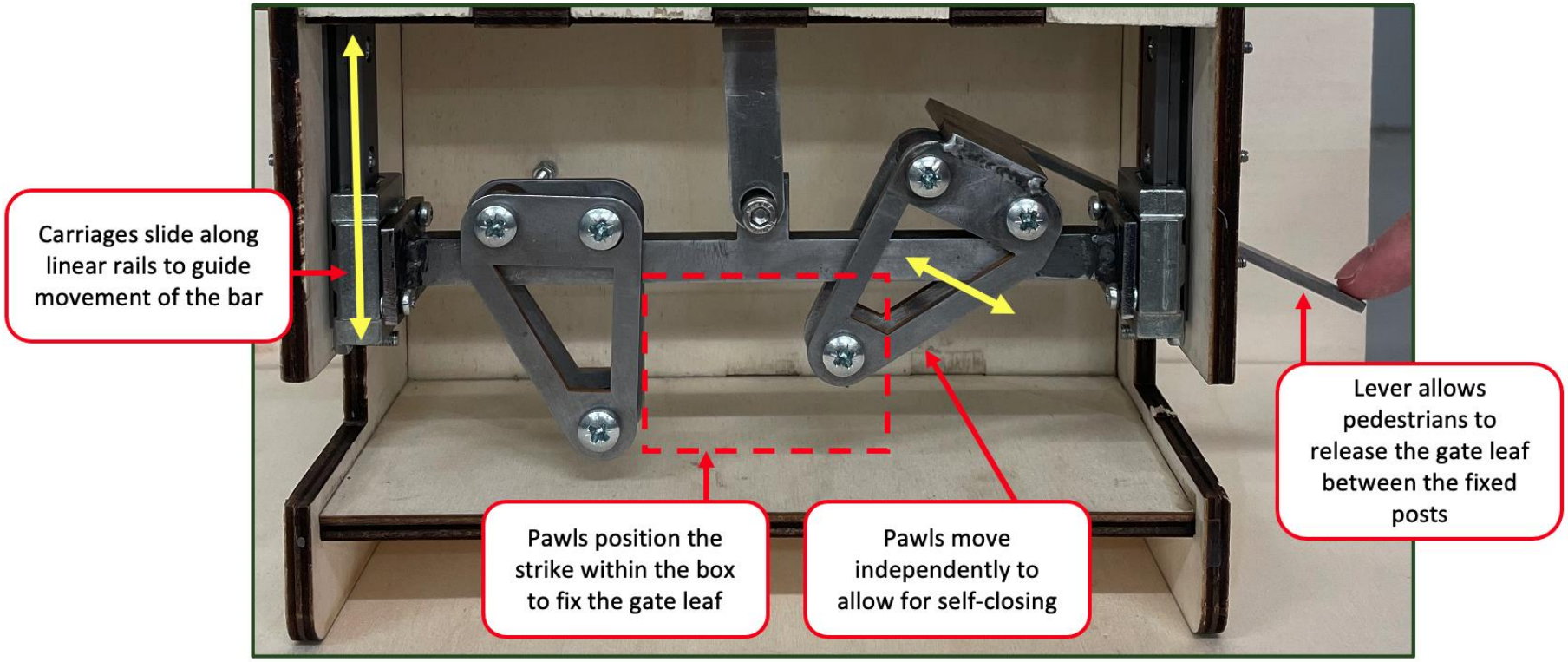




Crank-Slider Mechanism



Moving Pawl Mechanism



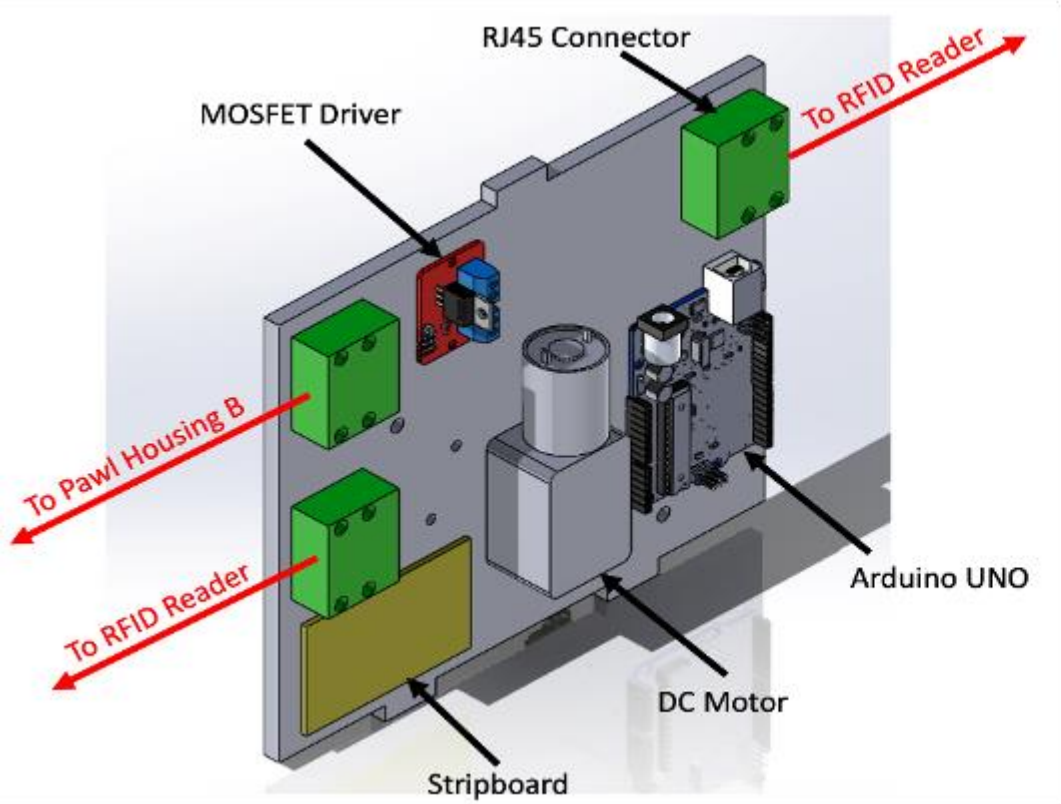
Electronic Functionality

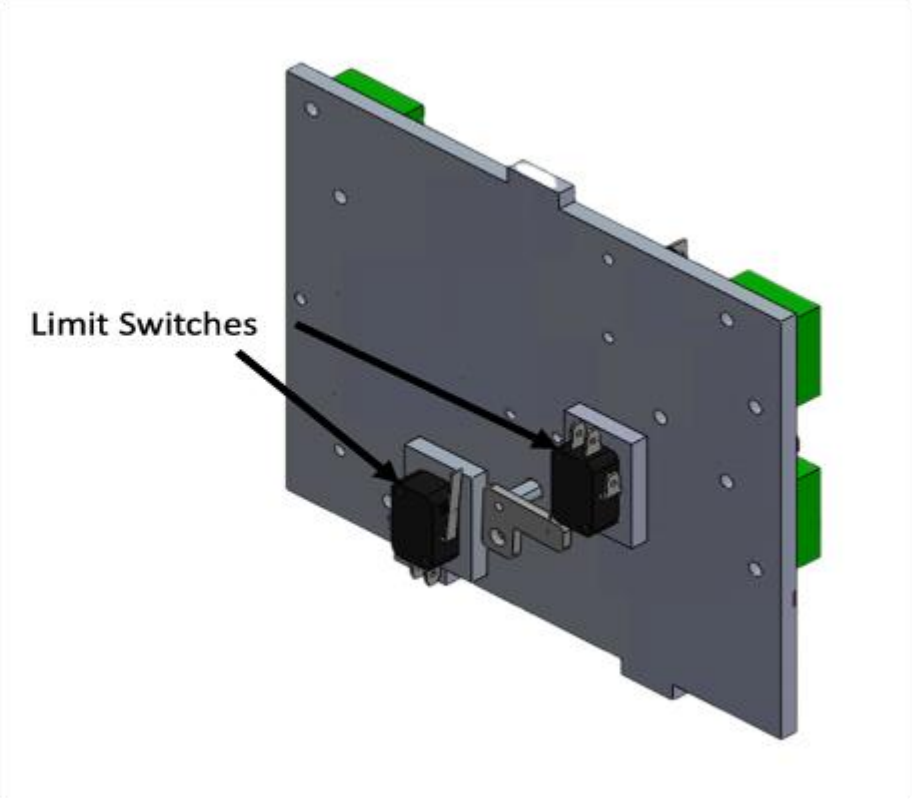
Requirements:

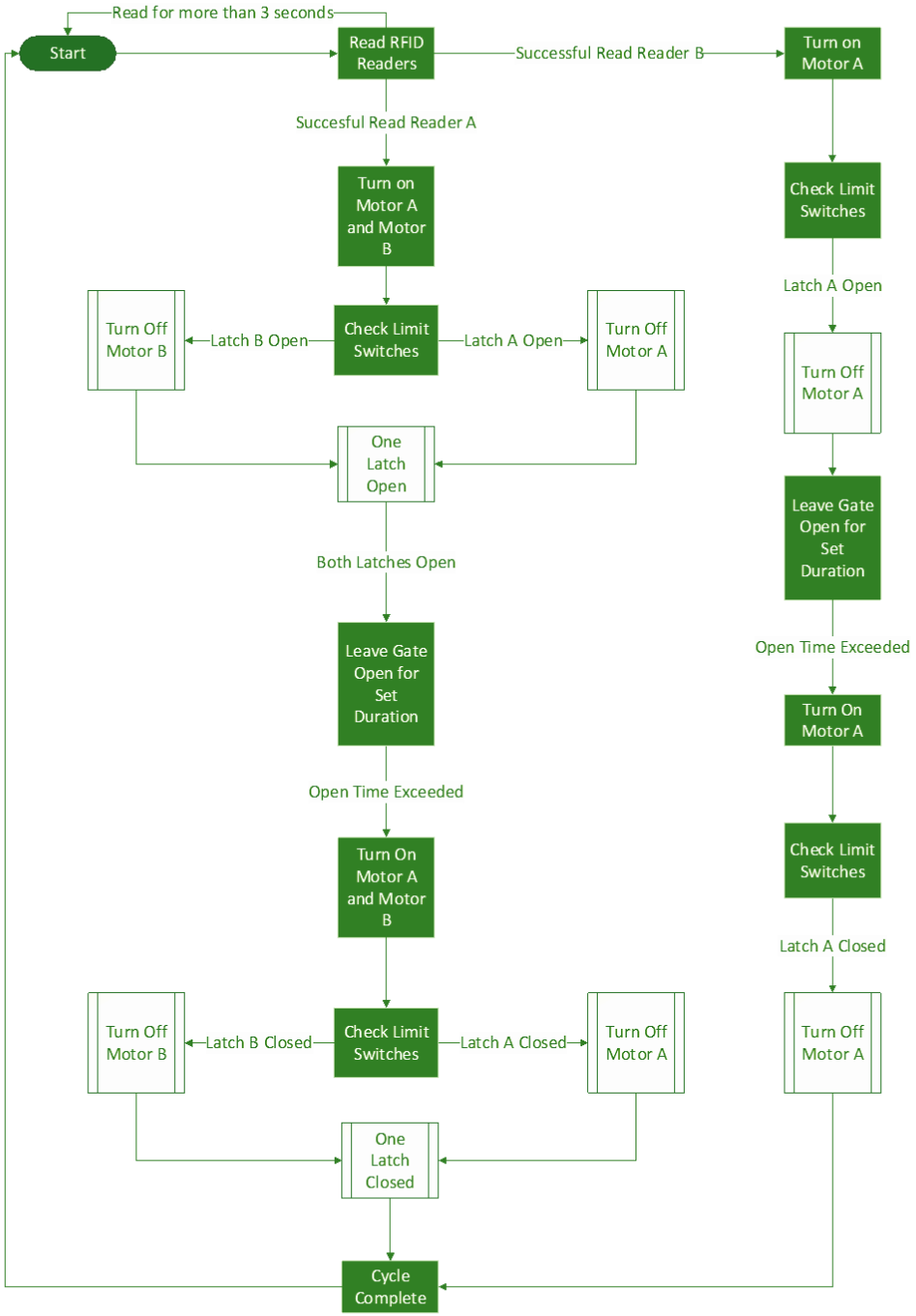
- Read RFID fobs
- Raise sliders
- Hold gate in open position
- Return to closed position

Components	Functions
Arduino UNO	• Determine state of circuit • Control components • Store master ID
RFID Readers	• Read RFID fobs
Limit Switches	• Determine slider position
DC Motors	• Raise/lower sliders
MOSFET Drivers	• Control power supply to motors
Ethernet Cables	• Transmit signals between components

Component Layout







State Machine Flowchart

Gate Hinges

- Required a **self-closing hinge** with **180° opening span**
- Raised mass returns gate to resting position
- **Adjustment** of resting position **unsuccessful**

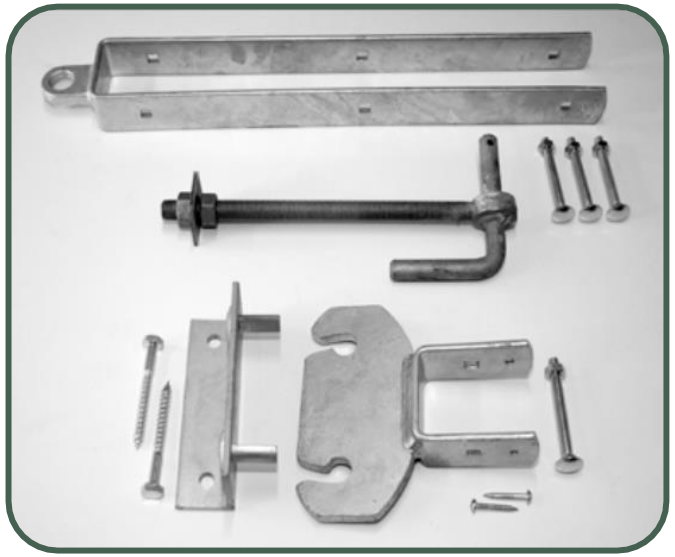
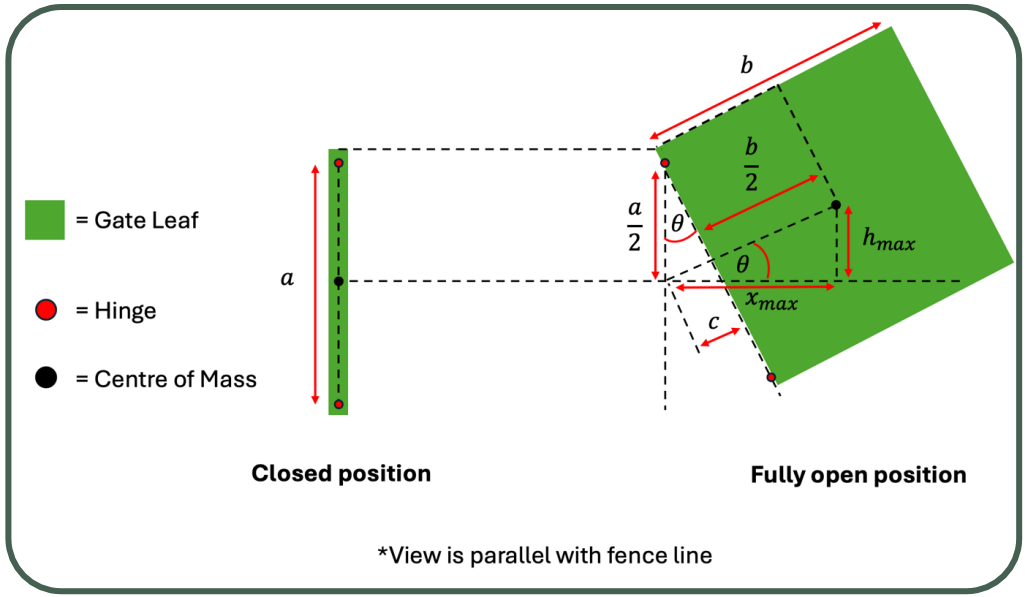
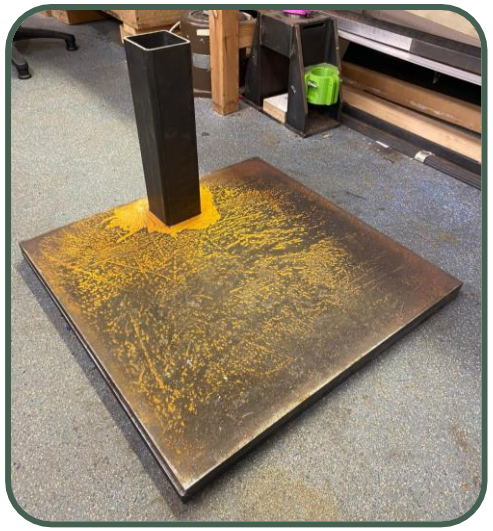


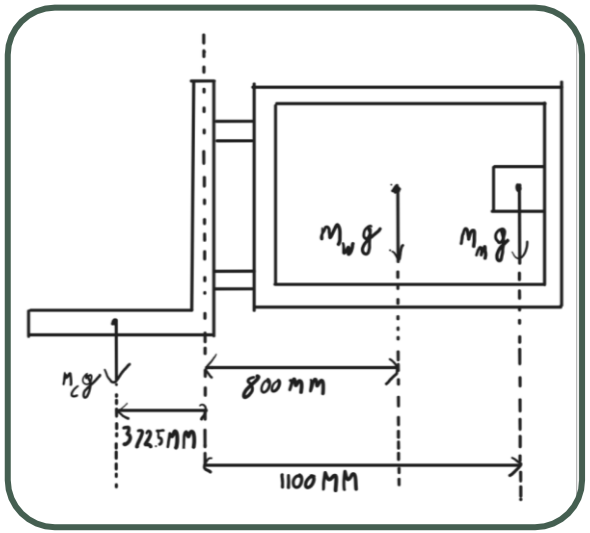
*Image taken from Centrewire 180° hinge installation instructions

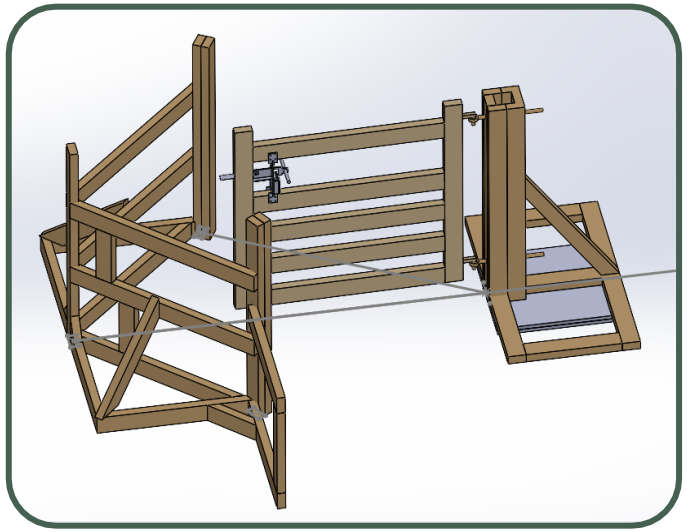


Free-Standing Structure

- Avoided obtrusions into the gate path
- **Calculated** required **balancing forces**
- Emulated strength of a sunk gate post







Testing Session Overview

Construction of free-standing, full-scale prototype

Tamper Testing

Strike Latching Functionality

Testing Session Overview

Ergonomic features tested

RFID Functionality

RADAR Padlock

Pedestrian Testing

Findings From Testing

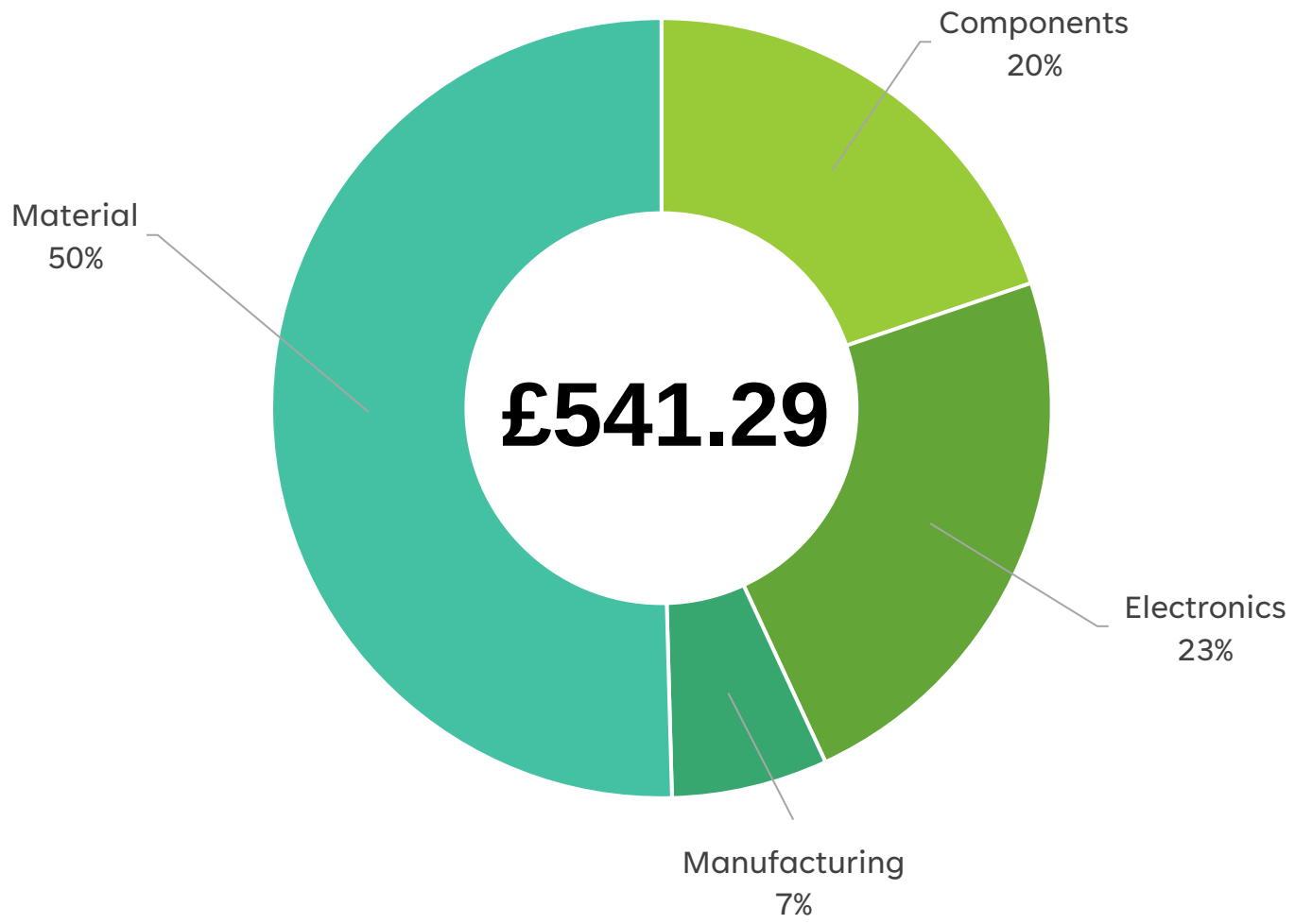
What We Tested	What We Learned
Positioning of the RFID readers	Database-informed position was suitable
Positioning of the pawl housings	Pawl housing can be difficult to align with moving strike
Opening duration for the gate	Optimal open time for the gate was around 10 seconds
Resting position of the gate	Offset hinges provide inadequate adjustment of resting position
Effectiveness of latching mechanism	Pawls too short
Effectiveness of tamper-proofing measures	Flanged pieces and thin strike are not preventative

Final Refinements

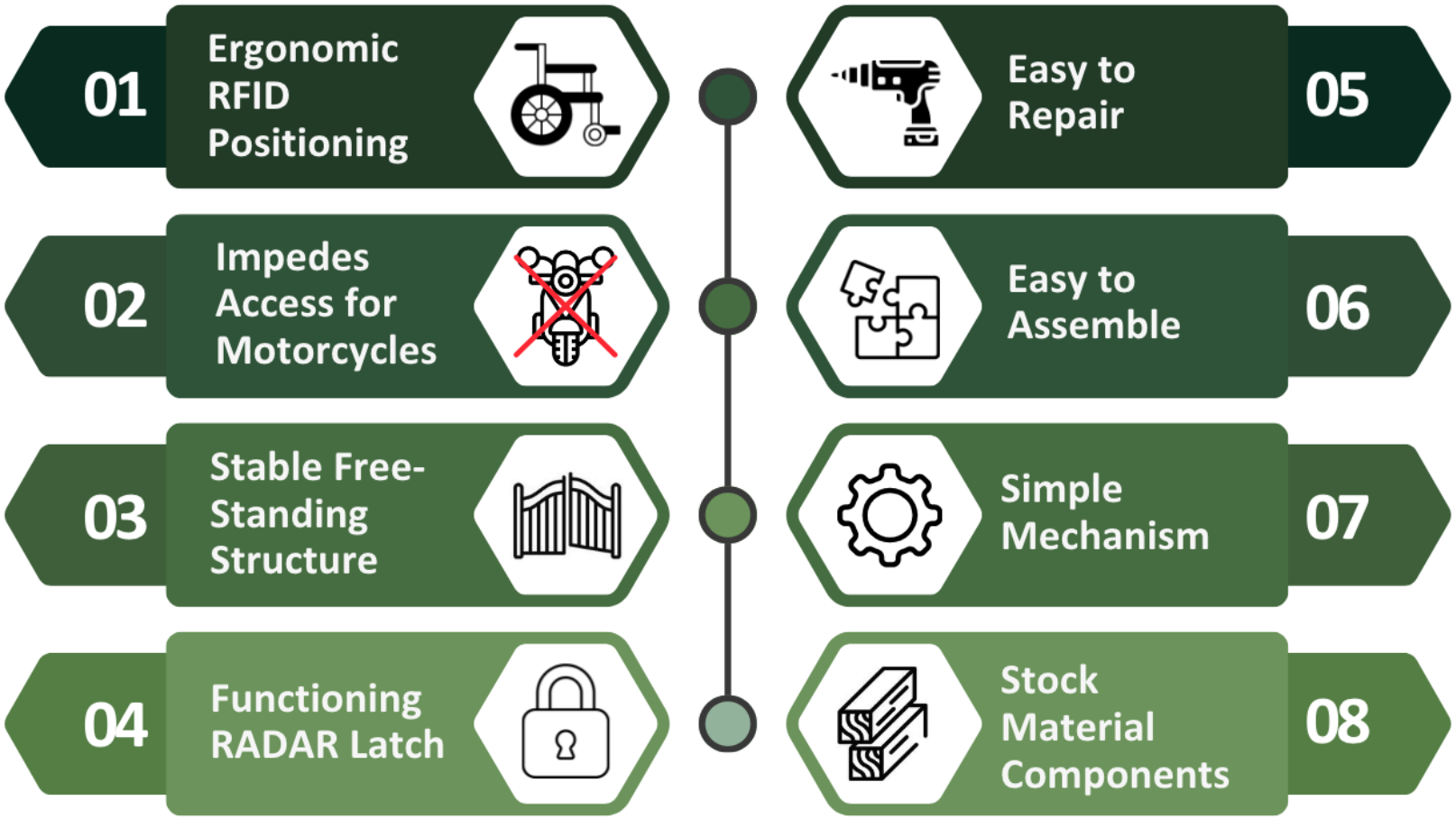
Project Review

Aim: Design and manufacture a prototype structure that is both motorcycle-deterring and more accessible for mobility scooter users than current designs on the market

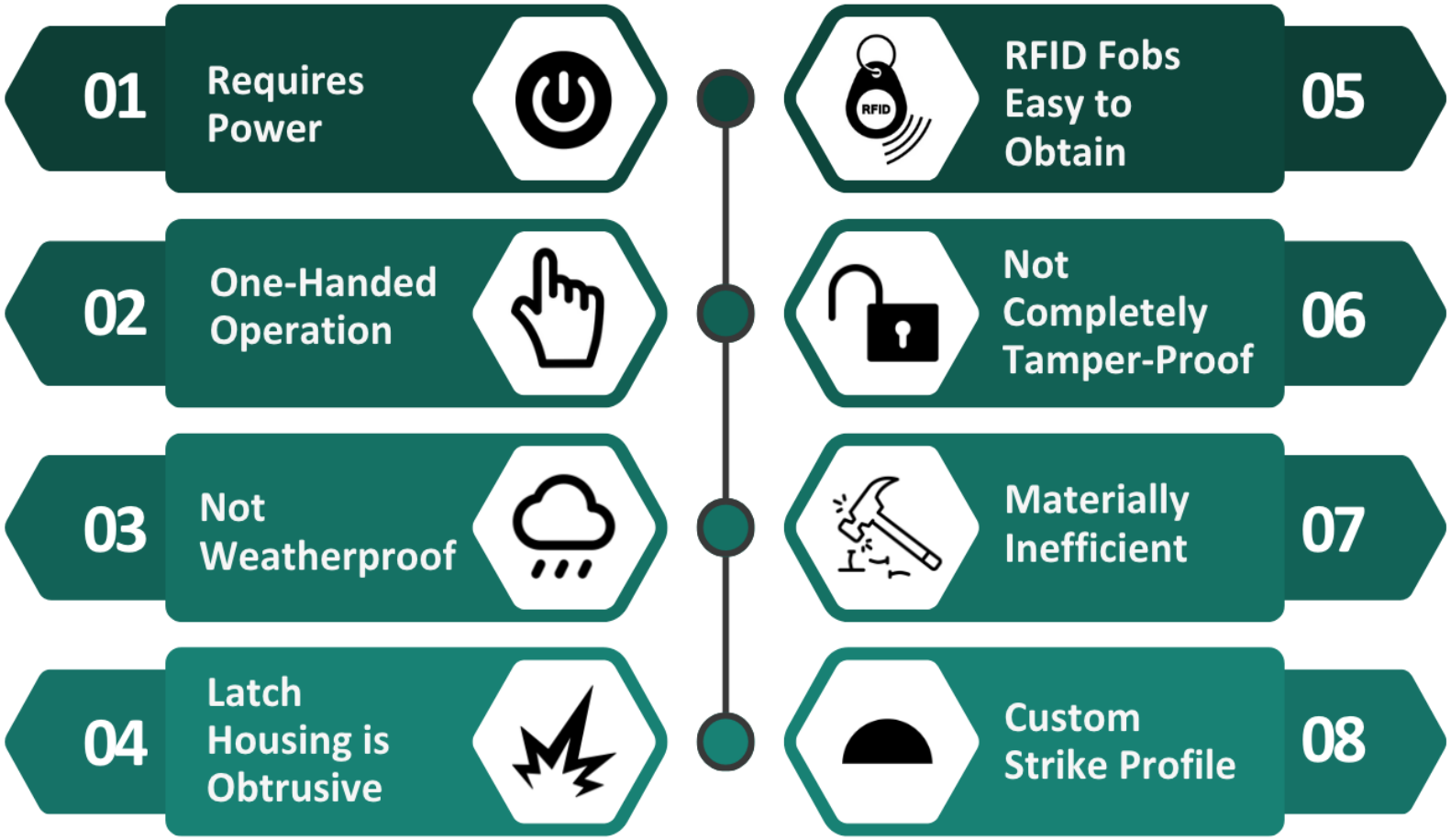
Cost of Prototype



Strengths


01
Ergonomic RFID Positioning
02
Impedes Access for Motorcycles
03
Stable Free-Standing Structure
04
Functioning RADAR Latch
05
Easy to Repair
06
Easy to Assemble
07
Simple Mechanism
08
Stock Material Components

Limitations



Project Review

Objectives:

1. Investigate existing designs and viewpoints of relevant stakeholders

   Motorcycle-deterring structures are not ergonomic for mobility scooter users.

2. Use product design specification to identify areas for improvement.

   PDS highlighted improvements could be made in positioning of unlatching mechanism.

3. Produce multiple design solutions that resolve the design brief.

   An RFID-based kissing gate was selected for prototyping.

4. Construct and test a full-scale prototype of a selected design.

   A free-standing gate was constructed and tested with a mobility scooter.

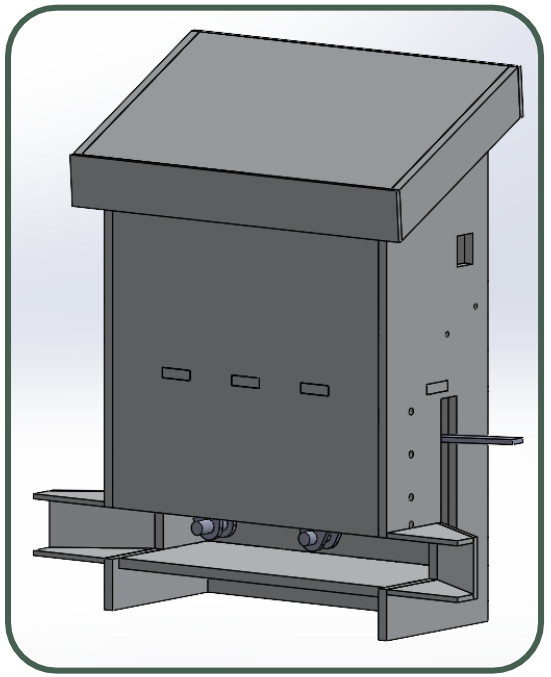
5. Use feedback from testing to suggest improvements to design.

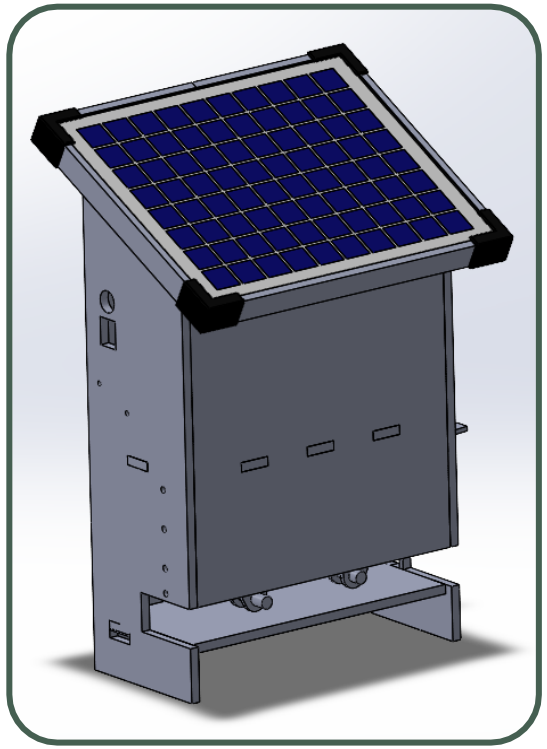
   Further design iteration produced after testing.

Future Work

Future Improvements

- Steel or aluminium welded casing
- Reassess required material thickness
- Add flanges to strike channel
- Reconfigure pawl housing mounting
- Improved components
- PV power source

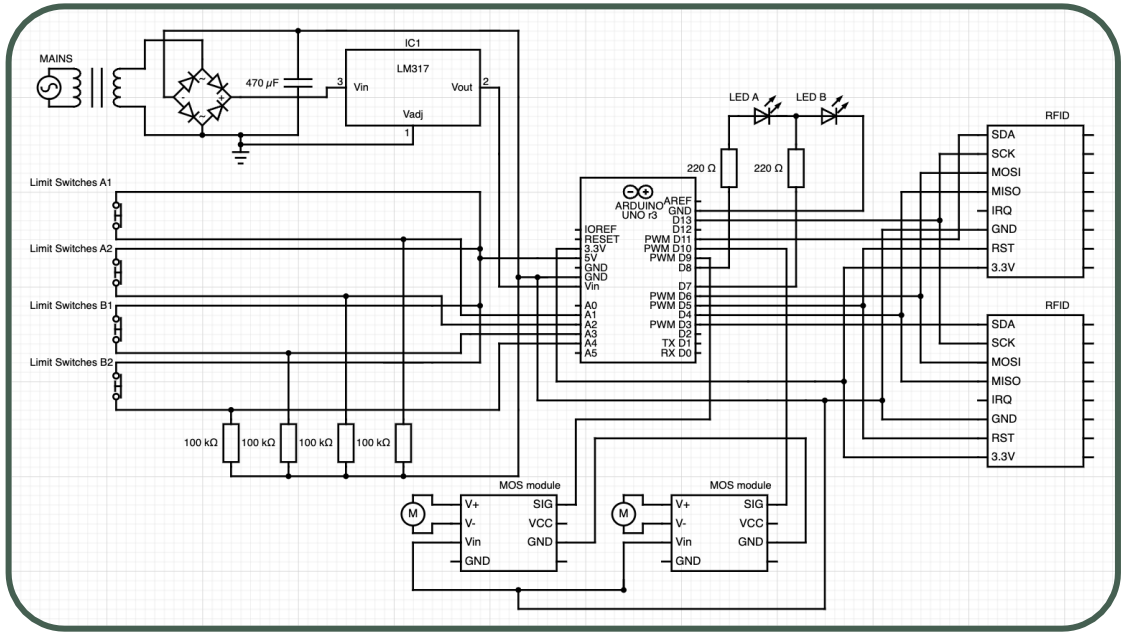




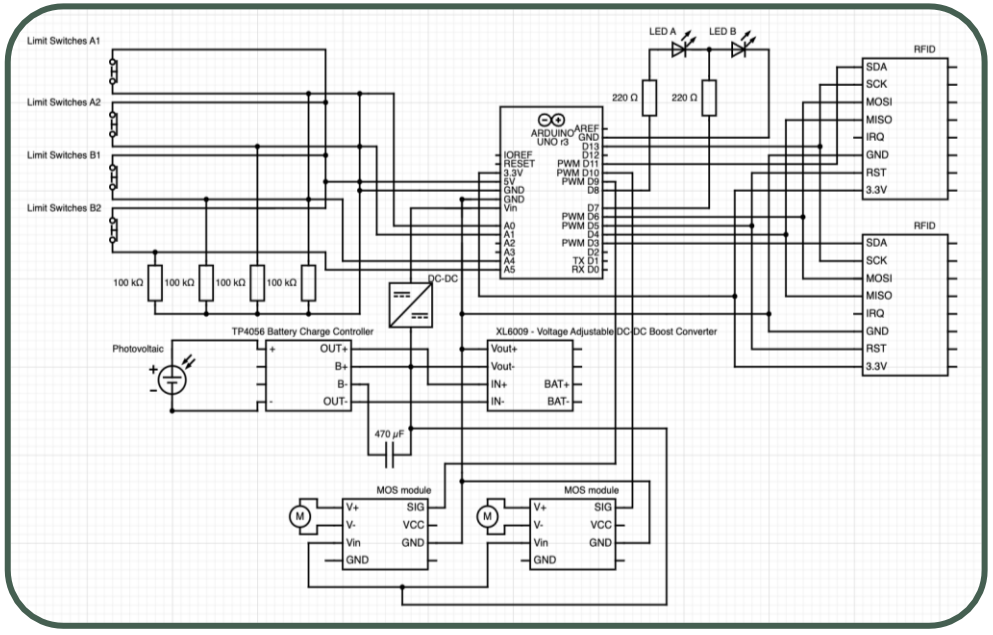
Power Solutions

Average energy consumption of 1.25Wh per day assuming 80 daily uses

- Solar solutions able to provide approx. 10 times power required
- Additional power charges backup battery



Mains Power Source



Photovoltaic Power Source

Thank you to...

- Participants & Volunteers
- Prof. Anna Barney
- Prof. David Richards
- Shail Patel
- Dr. Matthew Wright
- The Disabled Ramblers Charity
- The Centre for Outdoor Accessibility Training
- Val Woods
- Tom Bindoff
- Centrewire
- The Disabled Ramblers' community

Questions

Thank you for listening